

FIRST RECORD OF *GAMMARUS ROESELII* GERVAIS, 1835 (AMPHIPODA: GAMMARIDAE) FROM KOSOVO WITH ECOLOGICAL NOTES

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Knowledge of the composition and distribution of Gammaridae fauna in Kosovo is very poor. Amphipod specimens were collected monthly during 2010 at five sites in five different tributaries of the Toplluhë and Mirushë rivers in Kosovo. Three species of the genus *Gammarus* Fabricius, 1775 were found: *Gammarus balcanicus* Schäferna, 1922, *Gammarus fossarum* Koch, 1836 and *Gammarus roeselii* Gervais, 1835. *Gammarus roeselii* was found for the first time in the Republic of Kosovo at one site only, in the Banjë thermal spring, as the only Gammaridae species. The water temperature regime of this site (18-25 °C) enables constant reproduction. The population structure of *G. roeselii* was dominated by males during most of the research period, probably due to the fact that they reach maturity earlier than females and are characterized by faster growth.

Keywords: *Gammarus roeselii*, Kosovo, Amphipoda, first record

Kuçi, R., Ibrahim, H. & Gashi, A.: Prvi nalaz vrste *Gammarus roeselii* Gervais, 1835 (Amphipoda: Gammaridae) s Kosova s detaljima iz ekologije. Nat. Croat., Vol. 26, No. 2., 215-223, Zagreb, 2017.

Poznavanje sastava i rasprostranjenosti faune porodice Gammaridae na Kosovu je vrlo oskudno. Primjerci Amphipoda su prikupljeni mjesečno tijekom 2010 na 5 postaja na 5 različitih pritoka rijeka Toplluhë i Mirushë na Kosovu. Nađene su tri vrste roda *Gammarus* Fabricius, 1775: *Gammarus balcanicus* Schäferna, 1922, *Gammarus fossarum* Koch, 1836 i *Gammarus roeselii* Gervais, 1835. *Gammarus roeselii* je nađen po prvi puta za Republiku Kosovo na jednom lokalitetu, u termalnom izvoru Banjë, kao jedina vrsta porodice Gammaridae. Temperaturni režim vode na tom lokalitetu (18-25 °C) omogućava stalnu reprodukciju. U populacijskoj strukturi vrste *G. roeselii* tijekom većine istraživanog razdoblja dominiraju mužjaci, vjerojatno zbog činjenice da postižu zrelost ranije od ženki i karakterizira ih brži rast.

Ključne riječi: *Gammarus roeselii*, Kosovo, Amphipoda, prvi nalaz

INTRODUCTION

Amphipods are important organisms in aquatic food webs, contributing importantly to the material cycle, life and diversity in freshwater systems. Another important aspect of their presence, especially in freshwater environments, is their use as indicators of water quality (e.g. ALTERMATT, 2014) and in ecotoxicology assessment studies (e.g. DAVOLOS *et al.*, 2015). Gammaridae Leach, 1814 is the largest family

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of the crustacean order Amphipoda Latreille, 1816. Species of this family live in different habitats in freshwater, brackish and marine ecosystems, mostly on the bottom in shallow areas among stones, roots and vegetation (e.g. VÄINÖLÄ *et al.*, 2008).

The genus *Gammarus* Fabricius, 1775, with more than 200 species, inhabits marine and freshwater environments; while most are epigeal, some of them have been reported from caves and wells (KARAMAN & PINKSTER, 1977a; ÖZBEK *et al.*, 2013). Species of this genus are distributed in the Holarctic and Palearctic regions. Amphipod fauna of the Balkan Peninsula is moderately known thanks mainly to the taxonomic works by Stanko and Gordan Karaman and a few other authors (e.g. KARAMAN, 1934, KARAMAN, 1972, 1973, 1974; KARAMAN & PINKSTER, 1977a, 1977b; ŽGANEC *et al.*, 2010; GRABOWSKI & PEŠIĆ 2007; GRABOWSKI *et al.*, 2017), but there are areas where there is still lack of knowledge on the taxonomy, biogeography and ecological features of this order. Kosovo is one of the least explored countries in Southeastern Europe with regards to gammarids. Data on the distribution of gammarids at a few sites in Kosovo are provided only by IBRAHIMI *et al.* (2008), SHUKRIU (1976), ŽIVIĆ & MARKOVIĆ (2007) and ŽIVIĆ *et al.* (2012).

The goal of this paper is to contribute to the knowledge of the distribution, population and seasonal dynamics of three species of genus *Gammarus* (*G. roeselii*, *G. balcanicus* and *G. fossarum*) in the Republic of Kosovo.

MATERIAL AND METHODS

Quantitative samples of Amphipods were collected with hand nets (mesh size of 0.4 mm) on the bottom of five streams and were fixed in 70% ethanol in the field. Sampling was carried out monthly during 2010 except July. Specimens were sorted in the laboratory using a binocular microscope and were identified to species level using available keys (KARAMAN & PINKSTER, 1977a, b; KARAMAN, 1993). Females were distinguished from males by the characters given in KARAMAN & PINKSTER (1977a, b) such as presence of oostegite plates in females and genital papillae in males, as well as body size and setosity of pereopods. Juveniles were distinguished from adults by size where for all three species specimens < 8 mm were treated as juveniles and the rest as adults. Specimens are deposited at the Faculty of Mathematics and Natural Sciences, Department of Biology, University of Prishtina, Prishtina, Kosovo.

The following chemical parameters were measured during the investigation period using an HI 9828 multimeter: oxygen concentration and saturation, water and air temperature. Alkalinity was measured by titration of a 100 ml water sample with HCL 0.1 N with the use of methyl orange as indicator.

Gammarids were collected at five localities (Tab. 1, Figs 1 and 2), in five different streams, of which four (S2-S5) are in the Adriatic Sea drainage area and one, S1, is in the Black Sea drainage area. All sampling stations were located in the Municipality of Suharekë in southern Kosovo. Station S1 was located in Duhël, a tributary of Sitnicë River. Station S2 was located in southwestern part of Suharekë town in a stream that originates from Breshanc village. Station S3 is located in the southeastern part of Suharekë town in a stream which originates from Sharr Mountains. Station S4 is located in the north-eastern part of Suharekë town. The last station, S5, is a thermal spring located in the northwestern part of the Suharekë town. Three of the sampling stations are located in tributaries of the Toplluhë River in the Drini i Bardhë river basin (S2-Semetisht, S3-Leshan and S4-Dragaqinë). S5 - Banjë was located in a spring area of Banjë thermal springs which after few meters discharges into the Mirushë River.

Tab. 1. Locality data for the five sampling stations.

Code	Sampling stations	Latitude (N)	Longitude (E)	Altitude (m)
S1	Duhël	42° 25' 37''	20° 54' 9''	806
S2	Semetisht	42° 24' 34''	20° 47' 13''	423
S3	Leshan	42° 19' 40''	20° 48' 20''	389
S4	Dragaqinë	42° 22' 10''	20° 52' 36''	453
S5	Banjë	42° 27' 50''	20° 46' 43''	553

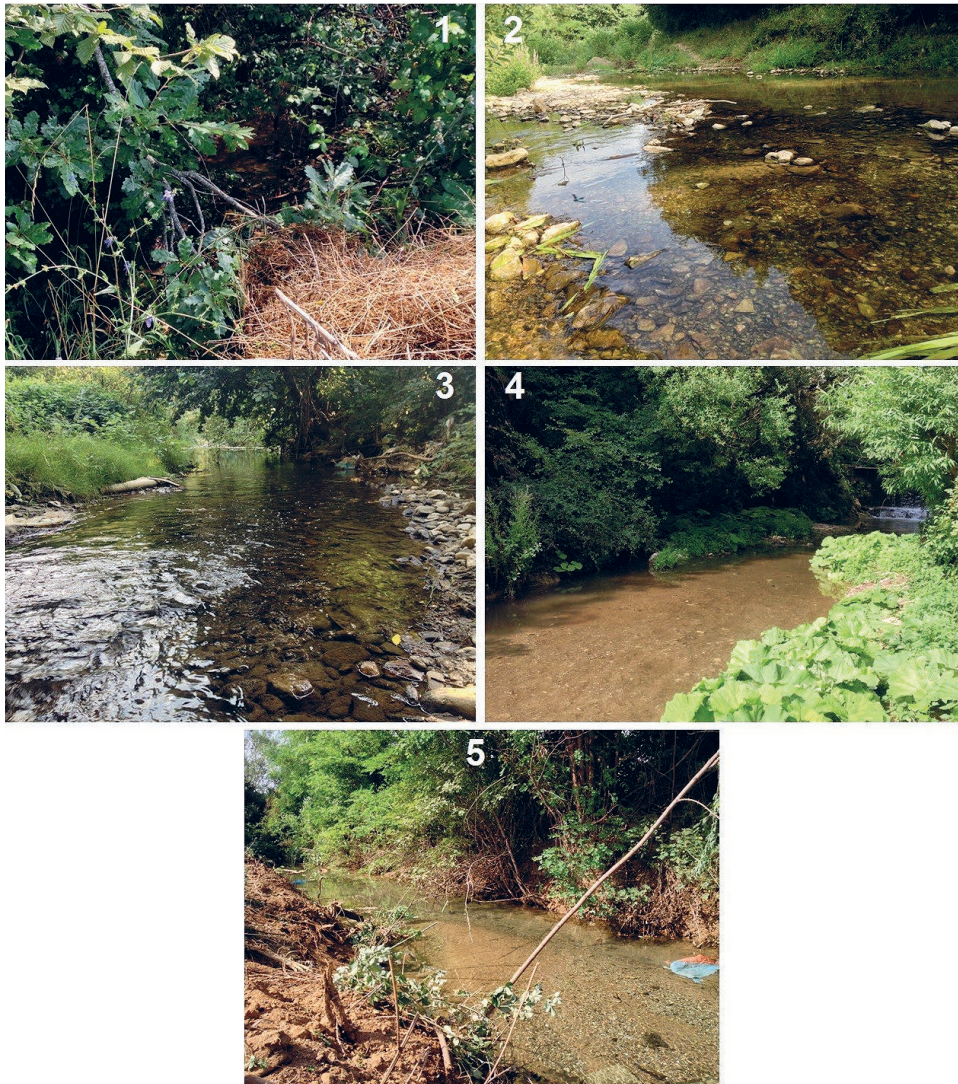


Fig. 1. Sampling stations: 1) S1 Duhël, 2) S2 Semetisht, 3) S3 Leshan, 4) S4 Dragaqinë and 5) S5 Banjë.

RESULTS

Three species of the genus *Gammarus* were found: *Gammarus balcanicus* Schaferna, 1922 at four sites (S1-S4), *Gammarus fossarum* (Linnaeus, 1758) at three sites (S1, S2 and S4) and *Gammarus roeselii* Gervais, 1835 at site S5. Species *G. balcanicus* dominated at four sites (Fig. 3) and at three sampling sites *G. balcanicus* and *G. fossarum* were found together in all months with low average relative abundance of last species (0.29-1.7%). *G. roeselii* was the sole species found at site S5-Banjë (Fig. 3). Analysis of the population structure of *G. roeselii* at site S5 revealed presence of egg-bearing (ovigerous) females during the whole year with the minimum percentage of 35.3 in October and maximum of 100% in December. Sex ratio (males/females) for *G. roeselii* varied between 0.69:1 during August to 1.47:1 dur-

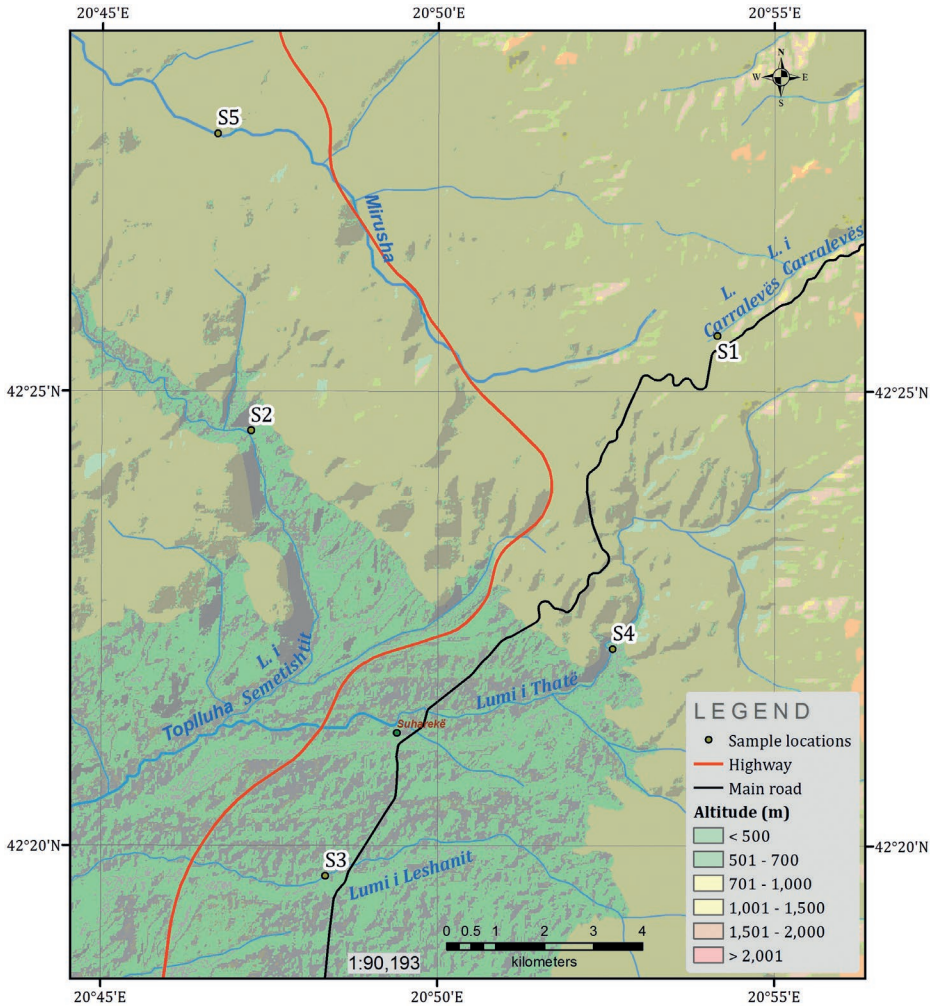


Fig. 2. Sampling stations and the hydrographic network of the research area: S1 Duhël, S2 Semetisht, S3 Leshan, S4 Dragaqinë and S5 Banjë.

ing February (Fig. 4). The highest percentage of juveniles in the population of *G. roeselii* is registered during November and January, the lowest during August and October. The number of eggs per ovigerous female of *G. roeselii* varied between 1 and 39, while average number of eggs ranged from 9.7 to 20.3 (Tab. 3).

Average water temperatures varied between 10.8 °C (S1 Duhël) and 23 °C (S5 Banjë). The lowest water temperature range was recorded at S5 Banjë and the highest at S4 Dragaqinë (Tab. 2). The highest average value for saturation with O₂ was registered in S5 Banjë (95%) and the lowest average value in S4 Dragaqinë (74.9%). Average values of dissolved oxygen in water varied between 7.89 mg/l (S4 Dragaqinë) and 9.74 mg/l (S3 Leshan). Average alkalinity ranges between 5.0 (S4 Dragaqinë) and 8.5 (S5 Banjë).

Tab. 2. Physical and chemical parameters at five sampling stations in 2010.

Sampling stations	S1 Duhël		S2 Semetisht		S3 Leshan		S4 Dragaqinë		S5 Banjë	
	Water	Air	Water	Air	Water	Air	Water	Air	Water	Air
Measured parameters	Average		Average		Average		Average		Average	
	10.8	13	14	16	12.5	14.3	12.7	15.09	23	15.1
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
	1.5	19	2	24	3.5	20	0.2	-1.2	18	-1
Temperature (°C)	Average		Average		Average		Average		Average	
	9.09		9.17		9.74		7.89		9.14	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
	6.49	11.35	5.8	12.08	6.78	13.89	4.82	10.69	6.49	10.77
Oxygen concentration (mgL ⁻¹)	Average		Average		Average		Average		Average	
	83.8		89.6		92.6		74.9		95	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
	60	121	59	116	73	125	42	97	71	135
Oxygen saturation (%)	Average		Average		Average		Average		Average	
	5.7		6.02		6.7		5		8.5	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
	4.5	6.7	5.3	6.9	6.3	7.9	4.4	5.9	8.1	9.3
Alkalinity	Average		Average		Average		Average		Average	
	5.7		6.02		6.7		5		8.5	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
	4.5	6.7	5.3	6.9	6.3	7.9	4.4	5.9	8.1	9.3

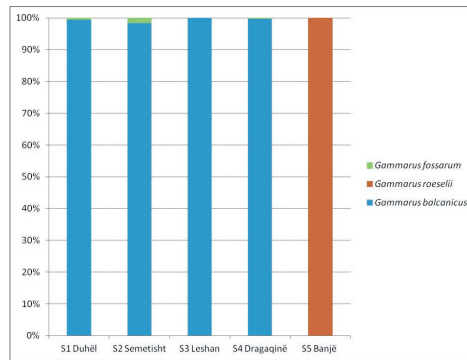


Fig. 3. Relative abundance of three species based on composite samples (all months summed) at all five sampling stations.

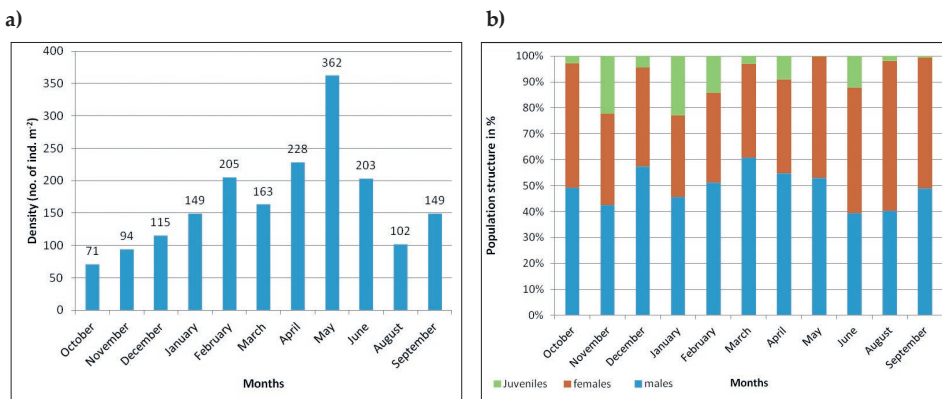


Fig. 4. a) Population density of *Gammarus roeselii* at site S5 Banjë in 2010; b) population structure of *G. roeselii* at the same site.

DISCUSSION

Two species from the family Gammaridae were reported from Kosovo (SHUKRIU, 1976; IBRAHIMI *et al.*, 2008; ŽIVIĆ *et al.*, 2012): *Gammarus balcanicus* and *G. fossarum*. In this study *Gammarus roeselii* was found for the first time in the Republic of Kosovo at one sampling station (S5-Banjë), which offers optimal conditions for the development of this species. *Gammarus roeselii* is a species of Balkan origin which is distributed in Asia Minor and across the European continent (KARAMAN & PINKSTER, 1977b; RUFFO *et al.*, 1988; ŽGANEC, 2009; GRABOWSKI *et al.*, 2017). In this regard Neogene palaeogeography provides a context for understanding the origin and distribution of cryptic diversity of amphipods in the Balkan Peninsula (GRABOWSKI *et al.*, 2017). The preferred habitat for *G. roeselii* are streams with moderate water current and abundance of plants; it can even survive in low oxygen concentrations and high temperatures (POCKL *et al.*, 2003; KARAMAN, 1993).

In this study *Gammarus roeselii* was previously found at a site located several hundred meters downstream of the Banjë thermal spring where the average annual temperature was 23°C (range: 18-25 °C). During our investigation we found that optimal temperature conditions for *G. roeselii* are warm streams while *G. fossarum* is optimally adapted for summer cool streams (PÖCKL *et al.*, 2003); *G. balcanicus* finds optimal conditions in summer cold streams (GRABOWSKI & MAMOS, 2011). Similar studies have shown that *Gammarus roeselii* is more successful in maintaining viable and highly productive populations in waters originating from thermal springs (PÖCKL *et al.*, 2003)

Tab. 3. Percentage contribution of ovigerous females within the total number of females and average number of eggs per female in *Gammarus roeselii* at S5 Banjë including minimum and maximum values.

	Percentage of ovigerous females within total number of females	Eggs
Months	%	Average (max-min)
October	35,3	11.2 (30 – 5)
November	97,0	20.3 (37 – 6)
December	100,0	15.9 (31 – 5)
January	95,7	15.3 (31 – 4)
February	95,8	16.9 (36 – 3)
March	91,5	15.1 (36 – 3)
April	93,9	15.4 (33 – 3)
May	98,8	16.8 (39 – 1)
June	96,9	12.7 (24 – 2)
August	76,3	9.7 (17 – 3)
September	93,3	17.1 (25 – 2)

During this investigation we have found a continuous reproduction cycle of *G. roeselii* throughout the year. Previous studies of *G. fossarum* and *G. roeselii* had shown that higher temperatures are generally associated with shorter life spans, faster brood development times, a tendency to produce more broods, and greater reproductive potential capacity in terms of succeeding generations (PÖCKL *et al.*, 2003). The lowest number of ovigerous females for *G. roeselii* was recorded during October. Similar studies reveal a reduced reproduction during autumn (PÖCKL *et al.*, 2003). In this study, the presence of ovigerous females has been recorded throughout the year in the other two species as well. The population structure analysis of *Gammarus roeselii* reveals that throughout the whole research period males are dominant in terms of number of individuals with the exception of June, August and September. The dominance of males as compared to female specimens in other species of the genus *Gammarus*, has been explained by faster growth and earlier attainment of maturity (CIUBUC, 1984; HYNES, 1955; KRANJČEVIĆ, 2009).

Accurate and detailed data on the diversity, distribution and ecology of species of the genus *Gammarus* are still lacking for several Balkan countries. Kosovo is one of the least explored countries of Europe in this regard and thus further investigations are needed in order to understand distribution patterns, ecological preferences and anthropogenic impact on the species of this genus. Currently most of the investigations in freshwater ecosystems in Kosovo are limited to water quality assessments (IBRAHIMI & GASHI, 2008; IBRAHIMI *et al.*, 2008) with some taxonomic data on EPT (Ephemeroptera, Plecoptera, Trichoptera) insect orders (e.g. GASHI *et al.*, 2015a, 2015b; IBRAHIMI *et al.*, 2014, 2015a, 2015b, 2016) but other groups of macroinvertebrates have been only fragmentarily investigated. This investigation contributes to the inventory of freshwater biodiversity of Kosovo.

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SUMMARY

First record of *Gammarus roeselii* Gervais, 1835 (Amphipoda: Gammaridae) from Kosovo with ecological notes

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The genus *Gammarus* with more than 200 species is distributed in the Holarctic and Palearctic regions. In the Balkan Peninsula the knowledge about this genus is moderate but there are areas where there is still a lack of data on the taxonomy, biogeography and ecological features of this order. Kosovo is one of the least explored countries in Southeastern Europe with respect to species of the Gammaridae family. During a one year period in five sampling stations in Suharekë Municipality in Kosovo three species of the genus *Gammarus* were found: *Gammarus balcanicus*, *Gammarus fossarum* and *Gammarus roeselii*. *Gammarus roeselii* is reported for the first time from the Republic of Kosovo and has been found in one locality only. This locality originates from a thermal water spring where the average yearly temperature is above 19 °C. Similar studies have shown that *Gammarus roeselii* is more successful in maintaining viable and highly productive populations in waters originating from thermal springs, while *G. balcanicus* and *G. fossarum* are well adapted to cool waters. The population structure analysis of *Gammarus roeselii* reveals that during most of the research period males were dominant, probably because of their faster growth and earlier attainment of maturity.